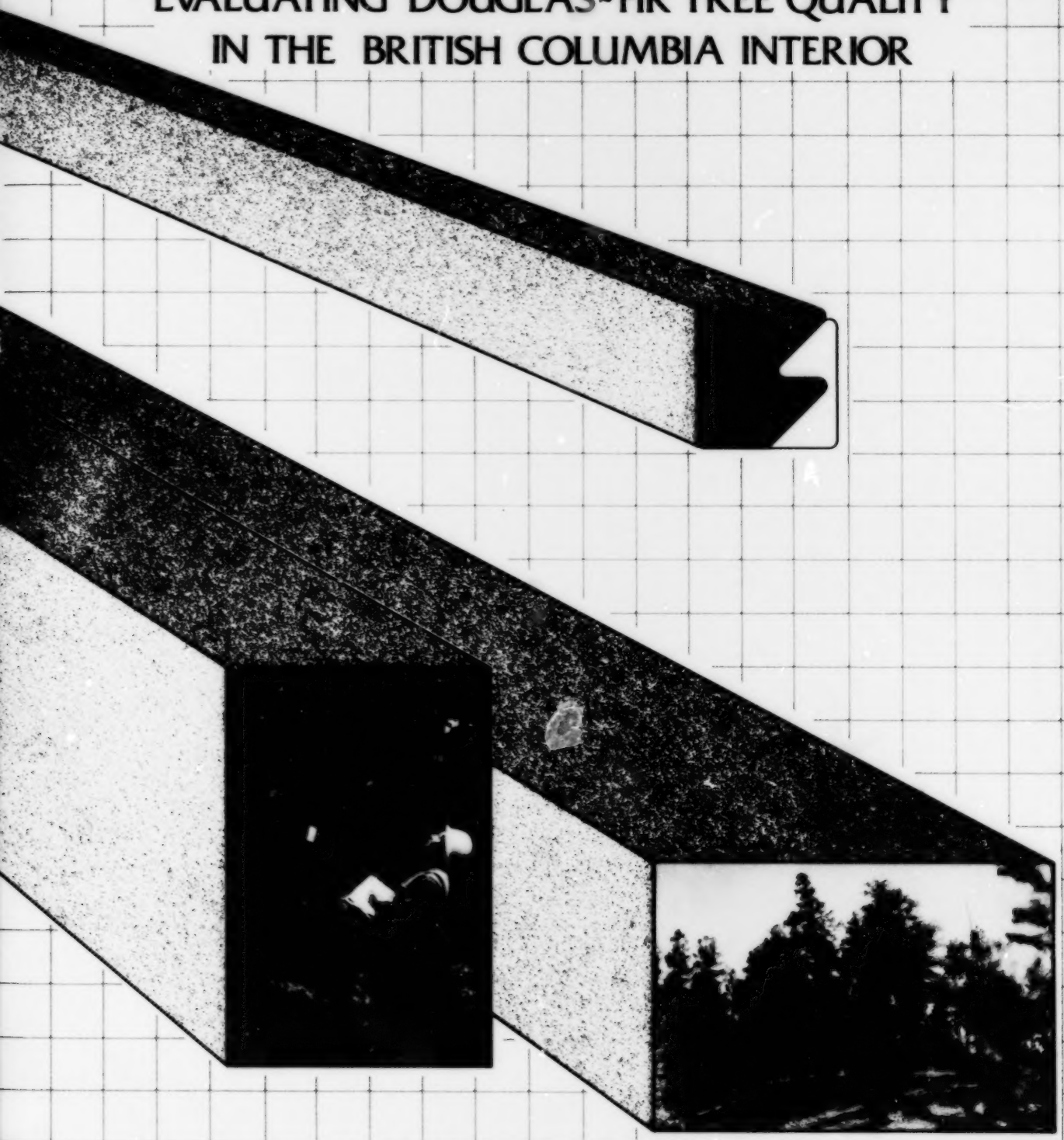
EVALUATING DOUGLAS-FIR TREE QUALITY IN THE BRITISH COLUMBIA INTERIOR



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EVALUATING DOUGLAS-FIR TREE QUALITY IN THE BRITISH COLUMBIA INTERIOR

by

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SUMMARY

In the late 1970s, Forintek participated in a study of Douglas-fir tree quality in the British Columbia interior. The study was undertaken by the Joint Interior Product Outturn Committee (JIPOC) which is comprised of members from industry, Forintek, and the British Columbia Ministry of Forests (BCMOF). JIPOC is responsible for identifying problem areas in the BCMOF's end-product appraisal system, conducting studies and making recommendations to the BCMOF.

The study objective was to determine if the quality of a Douglas-fir stand could be evaluated on the basis of the characteristics of the trees within it, thereby providing a more site-specific measure of stand value than that being achieved by the BCMOF's existing appraisal system in which the quality of an entire stand is determined according to its location within one of two geo-climatic regions: wet-belt or dry-belt.

Two sawmill studies were conducted in each of the three major Douglas-fir producing regions of the B.C. interior. Sample trees were selected and their quality characteristics were recorded. These trees were felled and their logs were processed into finished lumber from which individual tree values were calculated. The final sample consisted of 1,862 trees.

Because average lumber recovery factor (LRF) and average lumber value increased with increasing log size, tree value per unit volume depended primarily on tree size. To a lesser extent, differences in LRF and lumber value were related to tree characteristics other than size. From these relationships it was possible to separate trees of all sizes into two quality classes described in terms of tree form and pathological indicators.

Average sound log lumber recovery factors and percentage yields of lumber graded Number 2 and Better were determined by log top diameter classes for each of the two tree quality classes. An index was derived showing the effect of tree quality and tree size on average lumber value per unit volume.

Tree quality classes can be easily incorporated in the BCMOF's existing timber appraisal system, and will provide a more site-specific method of stand evaluation. Apart from its use in appraisals, product outturn information related to tree quality should be of interest to those concerned with evaluating their future timber supply. A description of each study mill is provided, and for those interested in sawmill efficiency, average sound log LRFs are compared. Sawmill recovery efficiency may be the most important factor in determining to what extent potential timber values are realized.

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OBJECTIVE

The study objective was to determine if differences in the quality of Douglas-fir in the B.C. interior could be assessed on the basis of characteristics visible in standing trees so as to provide site-specific measures of stand value.

INTRODUCTION

In 1977, as part of an on-going series of studies related to timber appraisal, the Joint Interior Product Outturn Committee, comprised of industry, the B.C. Ministry of Forests (BCMOF) and the Canadian Forestry Service (CFS), began an assessment of the quality of Douglas-fir [Pseudotsuga menziesii (Mirb.) Franco.] in the British Columbia interior. The Western Forest Products Laboratory (WFPL), representing the CFS, agreed to assist the committee to formulate study plans and to compile and analyze study results. The BCMOF provided the personnel required for data collection, and six interior companies provided access to their logging areas and milling facilities.

In 1979, following the completion of five mill studies, Forintek Canada Corp. assumed responsibility for the operation of the WFPL and agreed to continue the work on Douglas-fir tree quality. Subsequently, a sixth mill study was completed and a report summarizing all six studies was presented to the committee. JIPOC presented its report to the BCMOF in September 1983.

The BCMOF, for the purpose of stumpage appraisal, presently classifies interior Douglas-fir into two geographic zones related to climatic conditions: the wet-belt zone and the dry-belt zone. The quality of timber in the wet-belt zone is generally better than that of the dry-belt zone. This difference in quality is recognized in stand appraisals by the use of zonal lumber recovery factors (LRFs)[1] and zonal average lumber values[2] to calculate stumpage.

A problem with geographic classifications is that there are transition areas to which neither classification applies. Furthermore, once a stand has been identified as being within either the wet-belt or dry-belt zone that entire stand is appraised as though all of the trees in it are of uniform quality. It was recognized that these problems could be addressed if individual stands were appraised on their own merit.

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[1] LRF = lumber volume in board-foot measure (fbm)/log volume (m^3)

[2] The lumber values used in BCMOF appraisals are rolling three-month averages of reported sales values which are referred to as the average market value (AMV).

STAFF

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METHODS

TREE SAMPLES

Trees were selected from 26 different cutting blocks in the major Douglas-fir producing areas of the B.C. interior: the Cariboo, Kamloops, and Nelson forest regions shown in Figure 1. Sample sizes were predetermined on the basis of expectations regarding variation in tree size and quality obtained from reference to previous studies (MacIntosh, 1964; Lane, 1964; Lane *et al.*, 1970). Trees were selected systematically, not randomly, but those chosen reflected the range of size and quality available at each area. The following tree variables were measured or tallied according to standard BCMOF cruising practice (BCMOF, 1976a):

- Diameter at breast height (d.b.h.) (inches)
- Total height (feet)
- Lean and sweep (degrees)
- Height to first live limb (feet)
- Height to first dead stub (feet)
- Number of clear quarters in first two 16 foot logs
- Presence of dead or broken top
- Location by tree thirds of pathological indicators:
    - conk
    - blind conk
    - fork
    - crook
    - scar
    - frost crack

The sample trees were felled, and a record was made of pieces culled, broken and merchantable. Each merchantable log length was identified by tree number and log position.

Figure 1. Mill Study Locations.

LOG MEASUREMENTS

Following transport to mill yards, logs were bucked into mill-run lengths and BCMOF scalers determined their net cubic-foot volumes according to the B.C. Firmwood Scale (BCMOF, 1976c) which comprises:

- measurement to the nearest inch of top and butt diameters inside bark,
- measurement to nearest foot of log length, and
- measurement and deduction of decay and voids.

In addition to being measured as called for by the official scale, log diameters were measured to the nearest 1/10 inch so that logs could be accurately classified by log top diameter. Study crews measured the severity of sweep and shake and noted occurrences of spiral grain, scars, frost cracks and crooks to assist in the subsequent rationalization of lumber yields for individual logs.

METRIC CONVERSION

Study measurements were made and recorded in imperial units. Because Canada has since changed to the metric system, results previously summarized in imperial units have been converted to metric measure in this report.

MILL STUDIES

Study logs were fed intermittently into normal mill flows. Where sawmills had more than one processing line, study logs were sorted by size for the appropriate lines to make keeping track of them practical. The tree identification number of each log was recorded against a sawmill sequence number prior to the log entering the mill. The sequence was maintained by color-coding the study logs and spacing them amongst non-study logs at a rate which permitted the identification of recovered lumber. Lumber counts were made at each log or cant breakdown center in the sawmill to be used as an aid during data collation. Lumber from each study log was identified with that log's appropriate mill sequence number, and that identity was maintained through planing by subsequently matching the sawmill sequence numbers to another set of sequence numbers assigned at the planer mill infeed.

Sample logs were processed following each mill's normal practice. Exceptions were: hand-bucking at Study 1 required because logs bucked at the normal cut-off saws could not be ejected for scaling before entering the mill; and reductions in planer speeds at all mills required so that sawmill sequence numbers could be recognized and recorded.

The primary product produced at each mill was random length dimension lumber. Qualified graders provided by each co-operating company graded the study lumber according to paragraphs 114, 123, and 124 of NLGA Standard Grading Rules for Canadian Lumber (NLGA, 1977) for boards, structural light framing and structural joints and planks, respectively. BCMOF personnel tallied the grade and dimension of each piece.

PRODUCT PRICES AND TREE VALUES

Lumber prices used in calculating log and tree values were averages of those reported for random length Douglas-fir lumber for the three month period July to September 1978 (Madison's). To standardize results, lumber was priced according to the general marketing practice of including Select grade, segregated only at one study, with lumber graded Number 2 and Better.

A nominal value ($25 per interior bone dry unit) was assigned to chip volumes which were calculated using equations[1] and species chip-yield factors used by the BCMOF in their appraisal system (Juhasz, 1976).

Individual tree values were derived by matching lumber and chip yields to the appropriate logs, and logs to the appropriate trees. To be consistent with the unit of measure used in B.C. timber appraisals, and to avoid the obvious conclusion that greater total volume results in greater value, tree values were expressed in terms of average value per unit firmwood volume. Average value of each tree was based on the value of the lumber and chip volumes obtained from each of its logs. Logs broken during processing within the sawmills were assumed

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[1] Chip calculations (imperial units):

Small Logs

CHIPS (b.d.u./cunit) = (10.2 - LRF) x species factor

Large Logs

CHIPS (b.d.u./cunit) = (9.6 - LRF) x species factor
b.d.u. (bone dry units) = 2,400 pounds of zero moisture content chips
Cunit = 100 cubic feet
Species factor for Douglas-fir = 0.098

The higher constant derived for use in the chip-yield equation for small logs reflects the assumption that chipping-type headrigs are generally used to process small logs. Chipping headrigs convert to chips some of the wood that other headrigs lose to sawdust.

chipped, those broken prior to entering the mill were assigned zero value and included in the calculation of average tree value. It was recognized that the latter implied a relationship between the incidence of mill-yard breakage and tree quality. This relationship was considered valid to the extent that logs most susceptible to breakage would be those obtained from low quality trees, those that were forked, crooked or decayed.

Trees were excluded from the derivation of quality classes only if, during the course of the study, logs were lost which had merchantable volumes that amounted to more than 10 percent of the tree's volume.

RESULTS AND DISCUSSION

TREE QUALITY CLASSES

Multiple-regression analysis was used to identify initially those tree characteristics which had a significant impact on tree value. It was decided on the basis of low multiple correlation coefficients (R^2)[1] and for practical application, to quantify tree quality in terms of discrete classes rather than by use of regression equations.

Difference in tree value proved to be primarily dependent on the differences in tree size measured in terms of d.b.h. and tree height. The impact of tree size was so great as to overwhelm the effect that other tree characteristics had on tree value. Height and d.b.h. were removed, therefore, from explicit definitions of tree quality and the impact of tree size was accounted for through a breakdown of tree volumes into 5 centimeter log top diameter classes. (Top diameter classes of 5 centimeters were chosen to be compatible with those used in the BCMOF's appraisal system.)

With distributions of stand volumes by log size classes explaining the major source of variation in stand values, our analysis was directed toward finding and quantifying differences in tree quality that could be related to tree characteristics other than size. It was further focused on quantifying quality differences in terms of sound log

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[1] R^2 is a measure of the degree to which variation in the dependent variable (tree value) is "explained" by its relationship with independent variables (tree characteristics).

yields because the BCMOF has a well established method[1] of estimating reductions in stand volumes to account for decay, waste, and breakage. The result was a two-class system of tree quality based on significant differences in average tree values that existed in each of the six studies. Trees were classified as Quality Class I or II according to the presence or absence of visible indicators in certain tree locations as described below.

Tree Quality Classes

Quality Class I

No conks.
No dead or broken tops.
No fork or crook in lower two thirds.
No scars, rotten branches greater than 10 cm in diameter or frost cracks in lower third.
No major (greater than 10 degrees) sweep or lean.
Taper, [d.b.h.(cm)/height(cm)] less than 1:48.

Quality Class II

Trees of Lower Quality.

Table 1 shows the quality class distribution of trees obtained for each study. A more descriptive comparison of the complete tree samples obtained at each study area is provided in Appendix I.

Table 2 shows relative average tree values per net unit volume obtained for tree quality classes at each of the six mill studies. The relative values were arrived at by assigning a value of 100 to the lowest average tree value obtained, that of Quality Class II trees in Study 3, calculating by what percent each of the other class values exceeded that lowest value, and assigning them a value equal to 100 plus that percentage. These relative values show at a glance how the actual average values compared between mills as well as between tree quality classes.

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[1] The BCMOF classifies trees according to Risk Groups (BCMOF, 1976b) which are determined by the presence or absence of pathological indicators. Associated with each Risk Group are reduction factors that vary by tree d.b.h. classes. Stand volumes are reduced for decay, waste and breakage according to the proportion of trees determined to be in each Risk Group. These Risk Groups are designed to predict the incidence of decay in a stand as a whole. There are two Risk Groups for interior Douglas-fir.

Table 1.

Tree Samples by Quality Class and Mill Study

Quality Class	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6
			Number of Trees			
I	196	223	119	159	167	151
II	252	174	88	112	102	119
TOTAL	448	397	207	271	269	270

Table 2.

Relative Tree Values by Quality Class and Mill Study

Quality Class	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6
			Relative Value			
I	134	118	107	138	110	120
II	125	106	100	131	102	104

It is evident from Table 2 that average tree values differed more between some mills than between quality classes. The highest values were achieved in Studies 1 and 4. In those two studies, values obtained for Quality Class II trees exceeded the values obtained for Quality Class I trees in the other four studies. This could not be attributed to geographic location because Study 1 was some distance from Study 4 whereas both were in close proximity to studies which had considerably lower average tree values, Studies 2 and 5 respectively (Figure 1).

It was expected that differences in the distributions of tree heights obtained at each study would explain the differences in values between mills because tree height was the variable most strongly correlated with average tree value. This was partly true.

Tree height distributions illustrated in Figure 2 show that Study 3, which had the lowest average tree values in both quality classes, also had the shortest trees. However, a summation of the percentages provided on the bar charts in Figure 2 shows that the proportion of large trees, 30 meters and greater in height, was lowest (33 percent) in Study 4 which had the highest average tree values, and the proportion of large trees was greatest (62 percent) in Study 5 which, with the exception of Study 3, had the lowest tree values. The distribution of large trees in Studies 1 and 2 was essentially equivalent, 43 and 42 percent respectively, but the values for Study 1 trees were considerably higher than the values for Study 2 trees. These anomolous results indicate that factors other than tree characteristics play an important part in determining the extent to which potential timber values will be realized.

SOUND LOG LRF RELATED TO TREE QUALITY

The dependence of tree value on tree size proved to be primarily a reflection of the dependence of LRF on log diameter. Table 3 shows how sound log LRFs varied by log top diameter and quality class in each of the six studies. Study 3, with the lowest tree values, had sound log LRFs that were amongst the lowest obtained across the range of log sizes. Studies 1 and 4, which had the highest tree values, had the highest sound log LRFs.

Average sound log LRFs for the two tree quality classes are shown in Table 4. These were derived by fitting smooth curves (Figure 3) to the unweighted averages of sound log LRFs calculated for log top diameter classes in each study. (LRFs were extrapolated beyond the 70 cm top diameter class to fulfill technical requirements of the BCMOF appraisal system.)

FIGURE 2

COMPARATIVE TREE HEIGHT DISTRIBUTIONS

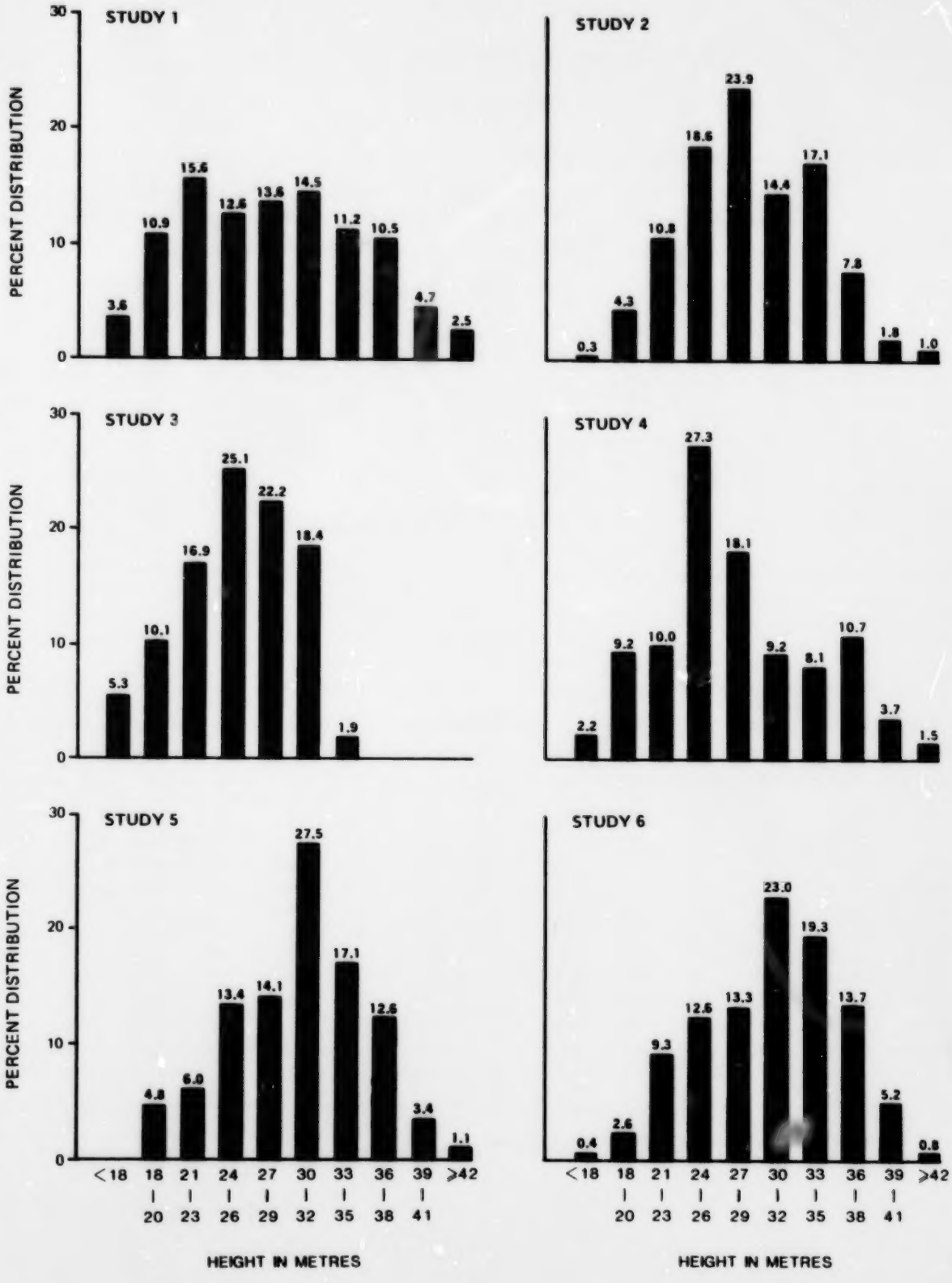


Table 3

Sound Log LRFs by Mill Study and Tree Quality

Quality Class I

Log Top Dia. (cm)	Study 1		Study 2		Study 3		Study 4		Study 5		Study 6	
	No.	LRF	No.	LRF	No.	LRF	No.	LRF	No.	LRF	No.	LRF
10.0 - 14.9	134	159	191	162	100	173	100	155	117	148	154	117
15.0 - 19.9	122	215	181	208	126	187	113	198	126	177	134	180
20.0 - 24.9	165	247	186	215	135	198	130	219	114	212	137	208
25.0 - 29.9	163	265	195	226	94	212	128	265	96	208	106	237
30.0 - 34.9	144	272	148	237	61	219	86	275	79	222	97	247
35.0 - 39.9	115	283	89	247	32	219	56	290	55	244	70	251
40.0 - 44.9	69	279	46	247	12	222	42	304	36	247	48	244
45.0 - 49.9	35	283	27	233	3	(237)	25	297	25	244	20	233
50.0 - 54.9	9	(283)	12	258	-	(240)	27	307	5	258)	8	(251)
55.0 - 59.9	4	(283)	2	(254)	-	(247)	10	(328)	2	(261)	2	(251)
60.0 - 64.9	1	(279)	1	(258)	-	(251)	1	(335)	-	(268)	1	(247)
65.0+	-	-	-	-	-	-	-	-	-	-	-	-

Quality Class II

Log Top Dia. (cm)	Study 1		Study 2		Study 3		Study 4		Study 5		Study 6	
	No.	LRF	No.	LRF	No.	LRF	No.	LRF	No.	LRF	No.	LRF
10.0 - 14.9	133	159	131	152	73	155	66	141	64	117	117	141
15.0 - 19.9	120	184	85	191	70	170	47	173	60	155	108	173
20.0 - 24.9	127	237	116	201	84	191	50	230	53	194	95	208
25.0 - 29.9	142	258	100	201	56	201	70	254	50	198	94	219
30.0 - 34.9	130	265	90	219	39	208	62	268	38	222	66	219
35.0 - 39.9	138	254	84	226	20	208	63	279	38	230	50	222
40.0 - 44.9	118	265	70	233	5	(222)	47	290	40	226	25	226
45.0 - 49.9	84	254	63	226	2	(230)	34	297	30	230	21	219
50.0 - 54.9	56	275	37	244	1	(233)	26	286	11	240	12	212
55.0 - 59.9	38	268	24	240	-	(240)	10	(304)	8	(233)	8	(201)
60.0 - 64.9	18	272	12	240	-	(244)	2	(307)	4	(230)	4	(191)
65.0+	12	283	10	(254)	-	(247)	1	(311)	3	(226)	3	(173)

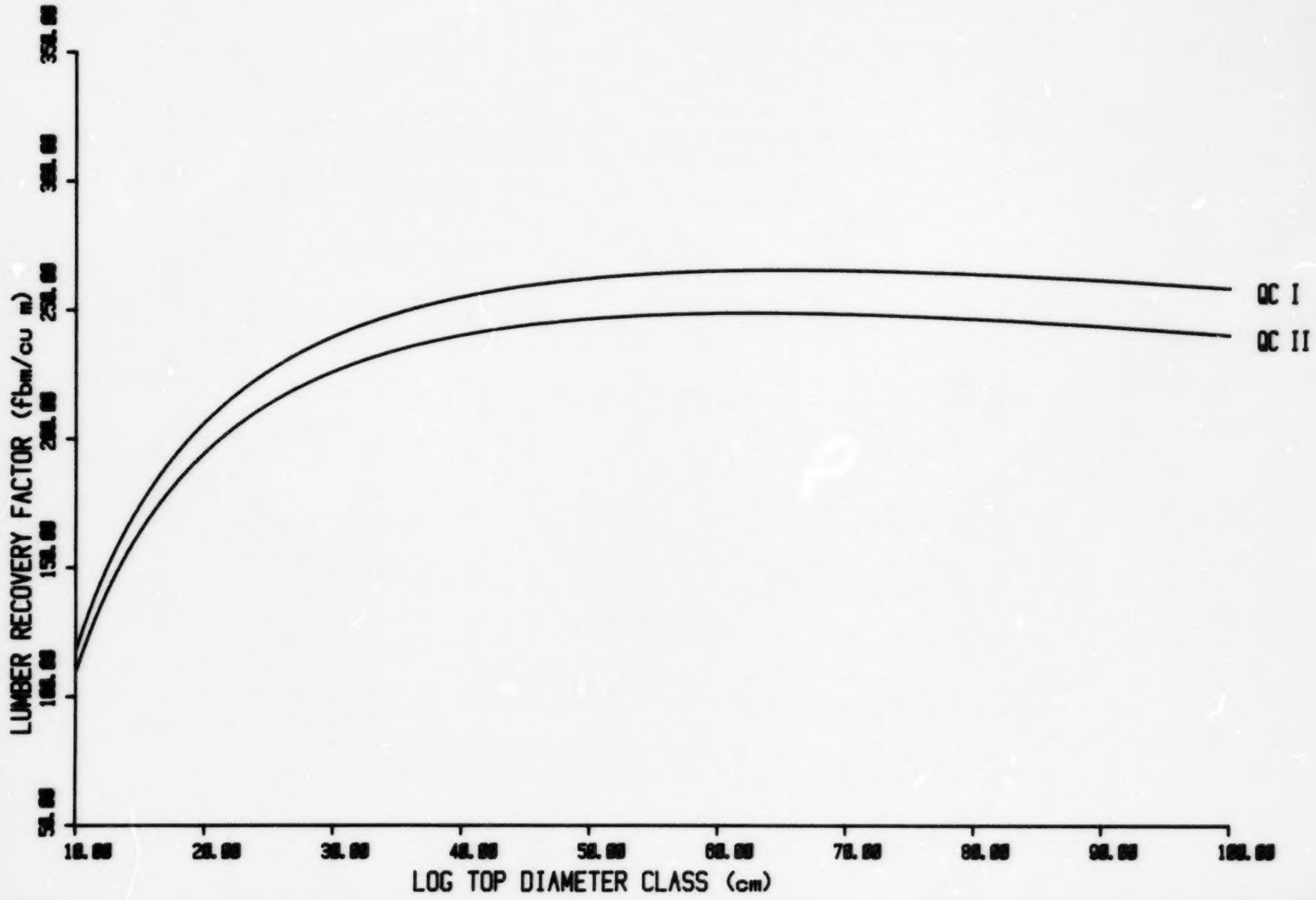
( ) = interpolated for $\leq$ 10 observations.

Table 4.

Sound Log LRFs by Tree Quality Class

Log Top Diameter (cm)	Quality Class I fbm/m^3	Quality Class II fbm/m^3
10.0 - 14.9	147	138
15.0 - 19.9	188	178
20.0 - 24.9	213	202
25.0 - 29.9	230	217
30.0 - 34.9	241	227
35.0 - 39.9	248	234
40.0 - 44.9	253	238
45.0 - 49.9	257	241
50.0 - 54.9	259	243
55.0 - 59.9	261	244
60.0 - 64.9	261	244
65.0 - 69.9	262	243
70.0 - 74.9	261	242
75.0 - 79.9	261	241
80.0 - 84.9	260	240
85.0 - 89.9	258	238
90.0 - 94.9	257	236
95.0 - 99.9	255	235
100+	255	233

FIGURE 3. SOUND LOG LRF BY TREE QUALITY CLASS



On the basis of recordings made by study crews, quality class LRFs were reduced by 1.72 percent to account for average losses in log volume incurred during short-log manufacturing and for average losses due to mill-yard breakage. These losses occurred before the logs were scaled for volume.

LUMBER VALUE RELATED TO TREE QUALITY

In addition to its impact on LRF, tree quality had a less significant but similar effect on lumber value per unit volume. Again, log diameter had an important influence. Trends are shown in the value index provided in Table 5. The index was prepared by assigning a value of 1.00 to the average value of all lumber produced and relating the lumber values obtained for each diameter and quality class to that overall average.

Table 5 shows that average value per fbm rises and then declines as log diameter increases. This is the result of higher prices obtained for wider lumber, 2x10's in particular. Average lumber value peaks in the diameter range where a single 2x10 cant is recovered and 2x10's represent the highest proportion of the recovery. Value per fbm declines beyond the 70 cm diameter log size as side lumber and additional small-width cants begin to make up increasing proportions of the lumber recovery.

It was recognized that lumber prices for various grades and dimensions do not always move in unison with cyclical changes in lumber markets. The stability of differences in value between the two tree quality classes was tested, therefore, by deriving tree values for a falling and bottoming lumber market to compare against the rising, peaking market represented by the 1978 prices used in the derivation of tree quality classes. The alternative lumber prices increased the difference in value that existed between tree quality classes, but the magnitude of change was inconsequential.

Lumber value differences between quality classes were due to differences in yields of premium lumber grades. Percentages of Number 2 and Better grade lumber recovered from the two tree classes are shown for log top diameter classes in Table 6. The percentages are unweighted averages of the results for the six studies. For logs less than 40.0 cm top diameter, the percentage yield of lumber graded Number 2 and Better is about 7 percent higher for Quality Class I than for Quality Class II trees. For logs 40.0 cm and over, the average difference is nearly 10 percent.

Complete lumber grade and dimension outturns obtained from each tree quality class are illustrated for each mill study in Appendix II.

Table 5.

Lumber Value Index by Tree Quality Class

Log Top Diameter (cm)	Quality Class I	Quality Class II
10.0 - 14.9	0.97	0.95
15.0 - 19.9	0.94	0.92
20.0 - 24.9	0.95	0.93
25.0 - 29.9	1.00	0.98
30.0 - 34.9	1.06	1.02
35.0 - 39.9	1.08	1.03
40.0 - 44.9	1.08	1.01
45.0 - 49.9	1.04	0.97
50.0 - 54.9	1.00	0.93
55.0 - 59.9	0.97	0.90
60.0 - 64.9	0.98	0.92
65.0 - 69.9	-	0.86

Table 6.

Percentage 2 and Better by Tree Quality Class

Log Top Diameter (cm)	Quality Class I %	Quality Class II %
10.0 - 14.9	88.6	83.1
15.0 - 19.9	89.6	82.6
20.0 - 24.9	89.3	84.5
25.0 - 29.9	87.7	83.3
30.0 - 34.9	86.3	80.5
35.0 - 39.9	84.7	78.6
40.0 - 44.9	84.8	73.7
45.0 - 49.9	80.0	68.4
50.0 - 54.9	75.7	62.8
55.0 - 59.9	70.3	59.6
60.0 - 64.9	75.9	61.1
65.0 - 69.9	-	53.1

APPLICATIONS

Should a tree quality class method of appraisal be implemented, a first step would be to classify stand volumes by diameter and tree quality and apply the average sound log LRFs derived here to estimate expected lumber volumes. This would capture much of the quality differential between timber stands because average tree value per unit volume was largely dependent on LRF.

Differences in stand values could be further defined by recognizing that average lumber values differ according to tree size and quality. The lumber values associated with each tree quality class reflect differences in the presence of decay, shake, spiral grain and other lumber grade reducing factors. As indicated previously, values (AMVs) assigned to lumber in the BCMOF's appraisal system are based on regional sales reports and in a broad way these already reflect regional differences in lumber size and grade outturns. However, it may be possible to improve assessments of stand values by adjusting these regional AMVs to reflect differences in lumber values that are associated with site-specific tree-quality and log-size distributions of stand volumes.

The lumber value pattern evident in Table 5 was consistent across all six studies, and it suggests a potential method of adjusting the reported AMVs to make them more sensitive to stand quality. Small logs in general, and large Quality Class II logs had lumber values below the average. Medium sized logs had higher than average values, with those of Quality Class I being the highest. Table 7 shows one way that the indices from Table 5 can be grouped to achieve some measure of AMV adjustment.

COMPARATIVE SAWMILL LRFs

It was not the intent of this study to analyze the production efficiency of the participating sawmills, and little information was gathered in that regard. However, the range of sound log LRFs achieved by the various mills indicates how important sawmill capabilities and cutting practices are in determining the extent to which potential timber values can be realized. Table 8 provides a description of the six study mills. Table 9 shows their associated sound log LRFs, and these are illustrated in Figure 4. The LRFs for Studies 1 and 4, which had the highest tree values, are considerably above the six mill average.

FIGURE 4. COMPARATIVE SOUND LOG LRFS

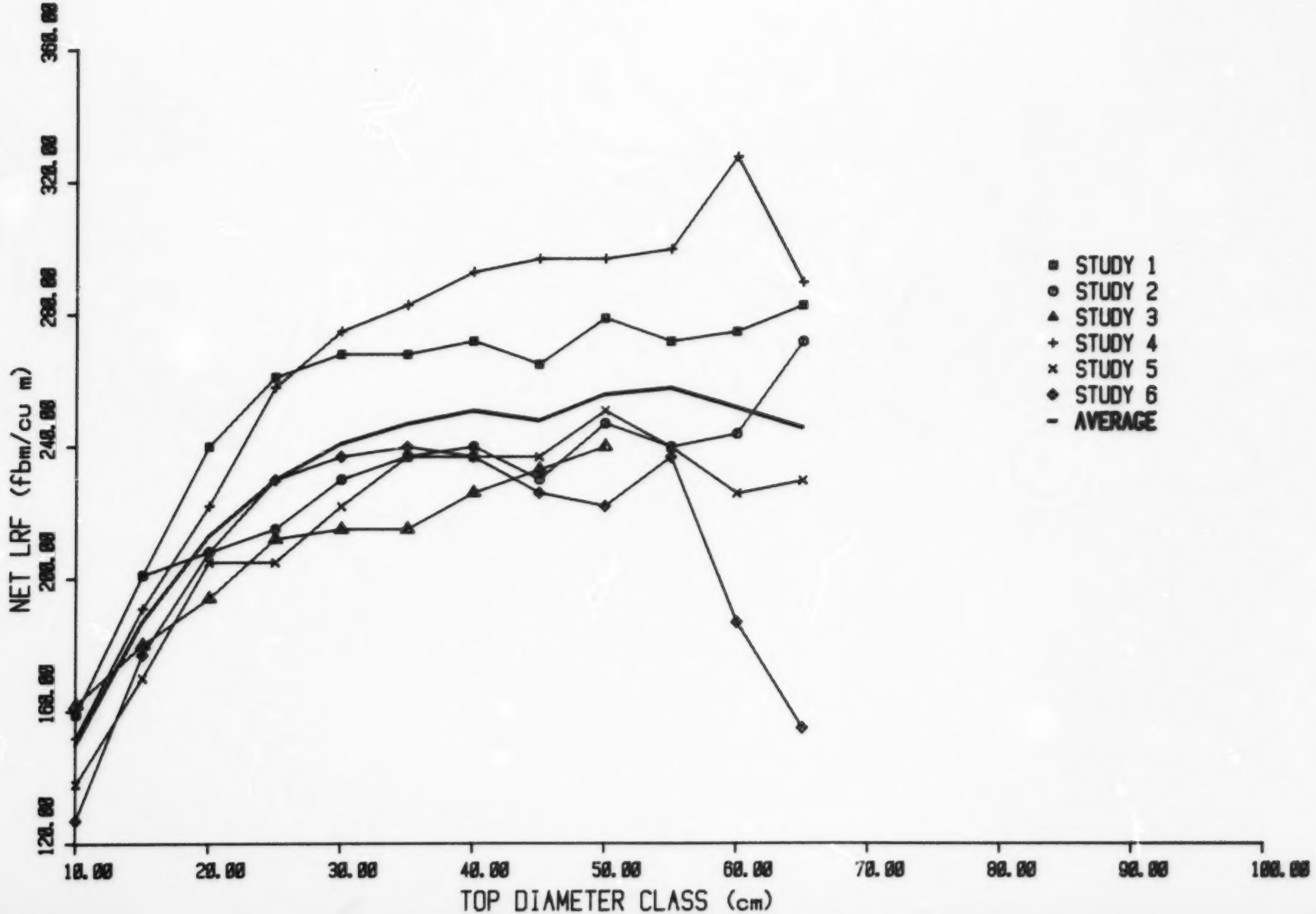


Table 7.

Factors for Adjusting Average Lumber Values For Log Size and Tree Quality

Log Diameter Class (cm)	AMV MULTIPLIER	
	Quality Class I	Quality Class II
10.0 - 29.9	0.97	0.95
30.0 - 49.9	1.07	1.01
50.0+	0.98	0.91

Table 8.

Sawmill Descriptions

Study	Mill Equipment
1	Circular headrig, double-arbor gang, 3-saw gang, band resaw.
2	Double-cut band headrig, circular gang saw. Chipper-canter, circular gang saw. 8/6/4 Profile chipping headrig.
3	Circular headrig, 30-inch sash gang, 3-saw edger, single band resaw. Chipper-canter, double-arbor gang.
4	Double-cut band, single-band resaw, 3-saw edger. 8/6/4 Profile chipping headrig.
5	Double-cut band headrig, Double-arbor gang, horizontal band resaw. Twin band, single-arbor edger.
6	Double-cut band headrig, sash gang, 3-saw edger.

Table 9.

Number of Logs and Sound Log LRFs by Mill Study

Log Top Dia. (cm)	Study 1		Study 2		Study 3		Study 4		Study 5		Study 6		Total Unweighted LRF
	No.	LRF	No.	LRF	No.	LRF	No.	LRF	No.	LRF	No.	LRF	
10.0 - 14.9	267	159	322	159	173	162	166	152	181	138	271	127	150
15.0 - 19.9	242	201	266	201	196	180	160	191	186	170	242	177	187
20.0 - 24.9	292	240	302	208	219	194	180	222	167	205	232	208	213
25.0 - 29.9	305	261	295	215	150	212	198	258	146	205	200	230	230
30.0 - 34.9	274	268	238	230	100	215	148	275	117	222	163	237	241
35.0 - 39.9	253	268	173	237	52	215	119	283	93	237	120	240	247
40.0 - 44.9	187	272	116	240	17	226	89	293	76	237	73	237	251
45.0 - 49.9	119	265	90	230	5	233	59	297	55	237	41	226	248
50.0 - 54.9	65	279	49	247	1	240	53	297	16	251	20	222	256
55.0 - 59.9	42	272	26	240			20	300	10	240	10	237	258
60.0 - 64.9	19	275	13	244			3	328	5	226	4	187	252
65.0+	12	283	10	272			1	290	3	230	3	155	246

CONCLUSIONS

The study demonstrated that the value (dollars/net cubic volume) of Douglas-fir in the B.C. interior is primarily determined by tree size, but is influenced by other characteristics (pathological and quality indicators) visible in standing trees. Based on these indicators, it was possible to segregate each of six tree samples into two tree quality classes which were significantly different in average tree value.

The importance of tree size proved to be a reflection of the impact of log size on LRF and average lumber value. This impact was best accounted for by a breakdown of stand volumes into log top diameter classes for which average sound log LRFs could be calculated. The impact of other tree characteristics was accounted for by a further breakdown into the two tree quality classes which produced significant differences in LRF, and differences in average lumber value, in all log size classes.

The ability to distinguish the quality of individual trees makes it possible to assess the value of any stand on the merit of the trees within it, eliminating the need for less precise regional definitions of stand quality. The words underlined in the description below indicate how quality classes can be used to refine measurements presently required to assess stand values under the BCMOF's appraisal system:

1. Total stand volume.
2. Stand volume distribution by log size and tree quality class.
3. LRF by log size and tree quality class.
4. LRF reductions for estimates of decay, waste and breakage.
5. Average lumber value by log size and tree quality class.

Tree characteristics, particularly size, have an impact on LRF, but their impact can be overshadowed by differences in levels of sawmill lumber recovery efficiency. The wide range of sound log LRFs obtained from the study mills demonstrates the importance of sawmill capabilities in determining the extent to which potential timber values will be realized.

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APPENDIX I

TREE SAMPLE DESCRIPTIONS

Tree Sample Descriptions

	Study No. 1		Study No. 2		Study No. 3		Study No. 4		Study No. 5		Study No. 6	
NUMBER OF TREES	448		397		207		271		269		270	
Average gross volume[1] (m^3)	2.35		2.10		1.12		2.14		2.07		1.97	
Average scaler deduction (%)	5.1		1.3		1.2		3.9		1.5		2.3	
Average yield i) lumber[2] (%)	49.7		44.5		40.9		53.4		43.9		43.7	
ii) chips[3] (%)	19.5		28.6		37.0		17.6		30.1		29.9	
TREE CHARACTERISTICS	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
d.b.h. (cm)	55.6	22.6-101.6	51.6	22.1-104.6	39.6	20.6-65.0	52.6	23.1-94.2	48.3	21.1-93.7	49.5	19.1-115.1
Height (m)	29.0	13.4- 46.3	29.7	17.7- 43.0	26.1	14.3-34.1	28.6	14.3-43.3	31.2	18.9-43.3	31.2	12.2- 45.7
Height to Live Limb (m)	7.6	1.5- 22.9	11.4	1.8- 19.8	12.8	2.1-27.4	7.8	1.5-21.3	10.3	1.5-22.9	12.0	1.2- 21.3
Height to Dead Stub (m)	2.2	0.3- 17.7	4.0	0.3- 16.8	0.6	0.0- 5.5	2.7	0.3-12.2	2.3	0.3- 9.1	2.5	0.0- 15.2
					Sample Affected (%)							
Pathological Indicators:												
- conk	0.2		-		0.5		1.1		1.5		0.4	
- closed scars	8.5		0.5		1.5		0.4		1.5		3.0	
- open scars	8.9		12.1		4.8		1.8		2.2		6.7	
- butt scars	2.9		12.8		2.4		5.2		7.4		3.3	
- fork or crook	17.0		15.1		35.8		9.2		12.6		13.0	
- frost cracks	15.2		3.5		1.0		0.4		1.5		3.7	
- rotten branches	0.1		0.5		-		-		-		0.7	
- dead or broken top	3.8		3.3		2.9		3.0		3.7		10.0	
Spiral grain	1.3		1.0		1.0		0.4		3.4		0.4	
Major sweep	6.0		2.8		9.5		2.0		5.3		8.9	
Major lean (<10°)	8.0		2.6		5.1		7.6		10.3		9.6	

[1]Excludes logging breakage
[2]Based on cubic volume of undressed lumber (1.0" or 1.7" x nominal widths)
[3]BCMOF formula based on sound log LRF

APPENDIX II

LUMBER GRADE AND DIMENSION OUTTURNS ILLUSTRATED BY TREE QUALITY CLASS

FIGURE 5

INTERIOR DOUGLAS FIR LUMBER GRADE DISTRIBUTION

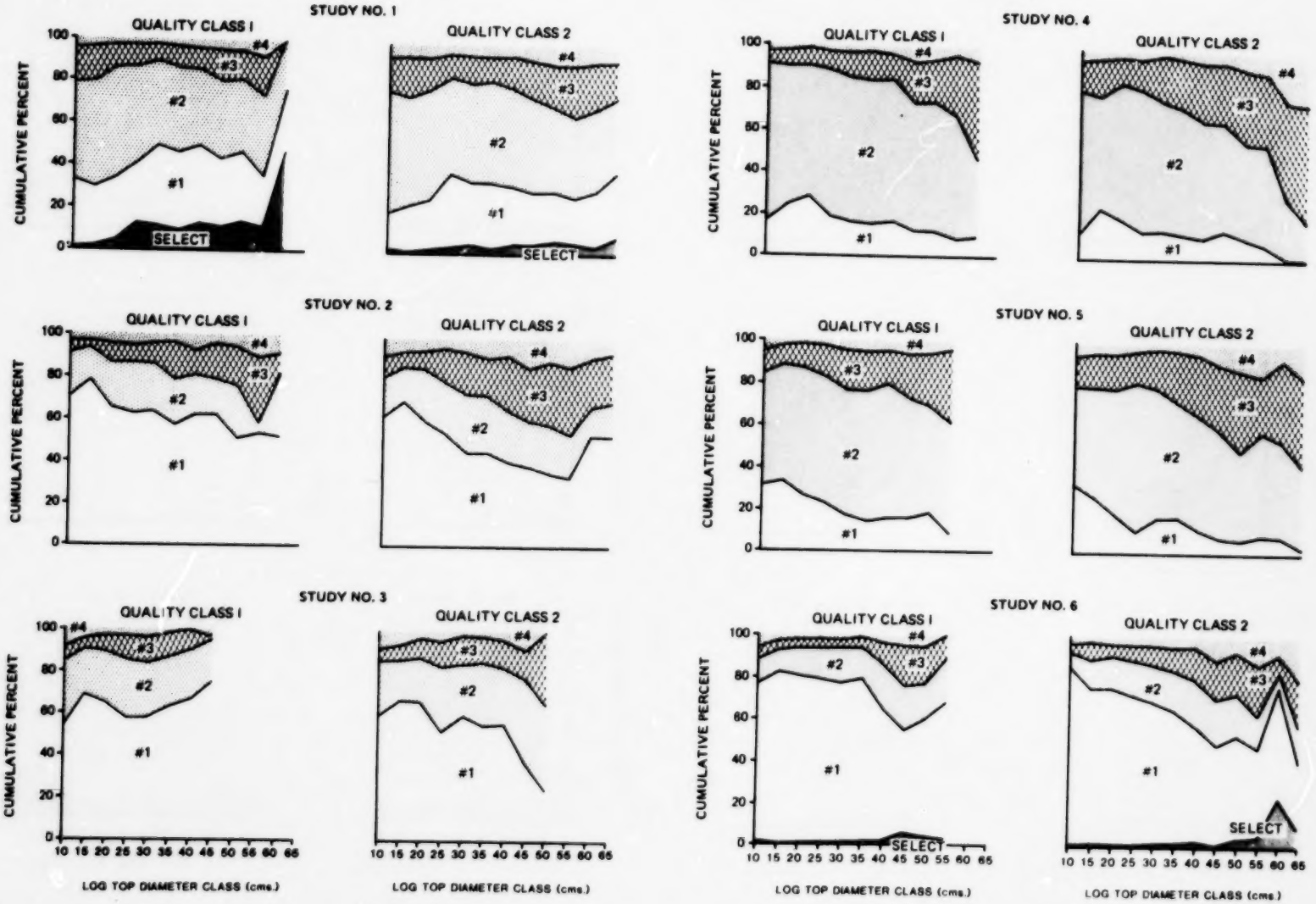

FIGURE 6

INTERIOR DOUGLAS FIR LUMBER DIMENSION DISTRIBUTION